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Research on Case Method for Japanese Prospective Teachers: Focus on Numeracy

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Abstract：*The purposes of this research are to investigate (1) some tasks of professional development of pre-service primary mathematics teachers through the handling of advanced query that student had, (2) the potential of case method for growth of pre-service primary mathematics teacher. For these purposes, a questionnaire was conducted on 91 pre-service mathematics teachers (undergraduate students). 6 examinees from that survey were then selected for interview survey. The results indicated two main points:*

(a) Japanese pre-service mathematics teachers would not realize the necessity of advanced mathematics to educate elementary pupils on arithmetic.

(b) Case method could be an effective tool to link between the practical decision making in classroom and mathematical subject matter knowledge.

Key Words：Case method, professional development, pedagogical knowledge

1. Introduction

To face the diversified tasks in school education, the social concern with practical ability of teachers have been growing for the last several years. In professional development of mathematics teachers, what is important is to keep the balance between mathematical expertise and pedagogical knowledge. The case method offers the key to an understanding of this kind of balance. Case method is one powerful teaching strategy to educate practitioners. About case method, the most controversial fields at present are legal, medical, and business professions (cf.HBS, 2008). Over the past few decades, a few numbers of studies have been made on case method in the field of teacher education (eg. Barnett, 1998, Walen & Williams, 2000, Schifter & Riddle, 2004). Specially, little attention has been given to pre-service primary mathematics teachers. This paper is intended as an investigation of this field.

The purpose of this research is two fold: 1) to investigate some tasks of professional development of pre-service primary mathematics teachers through the handling of advanced query that students had, and 2) to verify the potential of case method for growth of pre-service primary mathematics teacher.

2. Methodology

The outline of investigation as follows;

Participants; 91 pre-service elementary school teachers from undergraduate school (private university) were selected for this research. The reason why undergraduate students are selected as subjects is that they had no formal teaching experience without their private mathematics tutoring.

Data collection; Data were gathered in May 2008. Two types of data were collected:

(1) Questionnaire investigation; the questionnaire has two parts. Part A is to identify their belief about early mathematics and teaching it. Part B is the cases to check the interpretation, evaluation, and support for elementary pupils. Two cases were observed by participants, they were asked to respond in each case.

Table 1. Case1 in questionnaire

Case 1

Makiko was a 6th grade pupil. She asked the checking of multiples. "Well, 2008 is the multiple of 2. In similar way, can I have any method to check the multiple of 3 and 4 besides directly dividing? "

Task 1

1-1. Choose one of the followings:

(a) Do you consider her conception as desirable? Yes ⊢——⊣ No

(b) Do you want to make it the object of classroom discussion? Yes ⊢——⊣ No

1-2. As an elementary school teacher, how would you respond to her?

Table 2. Case2 in questionnaire

Case 2

Suppose you are teaching a 6th grade class (pupils about 12 years old).

You are discussing about divisor and multiple. A student named Ryuta asked you:

"Can we think about the divisor in the case of fractions?"

For example, $\frac{1}{2}\div\frac{2}{3}=\frac{3}{4}$, so that $\frac{2}{3}$ is a divisor of $\frac{1}{2}$?

Task 2

2-1. Choose one of the followings:

(a) Do you consider his conception as desirable? Yes ⊢——⊣ No

(b) Do you want to make it the object of classroom discussion? Yes ⊢——⊣ No

2-2. As an elementary school teacher, how would you respond to him?

(2) Clinical interviews; after questionnaire investigation, some typical participants were interviewed, and the interviews were audio-recorded, and transcribed.

Material; In part A of questionnaire, there are six questions for their belief as follows;

Q1. Early mathematics (arithmetic, in elementary school) is changing with times and areas.

Q2. Teaching of early mathematics should start from pupil's conceptions.

Q3. Early mathematics is nugget of defined routine rules.

Q4. Teachers need high order (advanced) mathematics to teach early mathematics.

Q5. Early mathematics is constructed from human activities.

Q6. Early mathematics is easier to teach than advanced mathematics.

Odd-numbered questions are focus on early mathematics itself, and even-numbered are focus on teaching and learning of it. The participants have four level choices; i) yes, ii) maybe yes, iii) maybe no, and iv) no.

In part B of questionnaire, there were two cases as shown table1 and table2. Each case described a situation in which the pre-service teachers had to respond to naïve question of elementary school pupils. Three features of cases used are as follows;

(a) Being problematic situations that need the decision-making as a responsible teacher.

(b) Being highly valued to essential matter about mathematics to become an expert early mathematics teacher.

(c) Keeping the reality of children's mathematical conception in their classroom.

Then the participant was asked to interpret what the pupil might have had in mind, and describe how they would respond to the pupils as a primary mathematics teacher.

3. Results of Questionnaire Investigation

Results of Part A and Discussion

A summary of the response is shown in table3.

Table 3. Result of question for their belief

N=91	Yes	Maybe Yes	Maybe No	No
Q1(P)	22	45	16	8
Q2(P)	16	36	26	13
Q3(N)	5	11	31	44
Q4(P)	3	6	26	56
Q5(P)	40	37	9	5
Q6(N)	9	41	22	19

The major tendency in table3 could be interpreted in two senses. Firstly, Japanese pre-service teachers might think that early mathematics is changeable, flexible, and arisen from human activities.

This result basically shows desirable aspect of their belief. Secondly, pre-service teachers would not realize the necessity of advanced mathematics to educate elementary pupils on arithmetic. These are the points to be specially considered for professional development of primary mathematics teachers.

Results of Part B and Discussion

A summary of the kinds of response is shown in the following tables.

Table 4. Result of task1-1

N=91	Yes	No
Task 1-1(a)	74	17
1-1(b)	39	52

Table 5. Result of task 2-1

N=91	Yes	No
Task 2-1(a)	69	22
2-1(b)	20	71

It might be inferred from these responses to both tasks that although they accept the pupil's naïve ideas, they might not wish to discuss these advanced topics.

Table 6 and Table 7 show various interpretations in two cases. Subjects were allowed to write down more than one answer in task1-2, 2-2. Approximately, third part of pre-service teachers could not do anything for Makiko & Ryuta's conception about divisor and multiple.

Table 6. Result of task 1-2

	To show the checking method for "3" and "4"	To teach the key idea of divisibility relation	To ask Makiko what is commonality of checking ways	Blank (no response) and so forth
Subjects (n=91)	51	4	17	32

Table 7. Result of task 2-2

	To encourage Ryuta to define of divisor	To check his idea by reading math text book, together.	To ask Ryuta the definition of divisor and set him relinquish it	Blank (no response) and so forth
Subjects (n=91)	13	46	36	25

What needs to emphasized is slightly lack of awareness for mathematical nature of these cases (divisibility relation). On the whole, it seems that most of them do not have confidence of treating of pupil's naïve conceptions.

Since it is complicated to investigate each correspondence of the interpretation and supporting in each case, we referred to the result of task 1-1, 2-1. Analysis of tasks 1-1 and 2-1 were conducted in order to determine whether the difference among pre-service teachers' views was statistically significant.

Table 8. Result of Task 1-1

(a)	(b)	Using Makiko's conception for discussion	
		Positive	Negative
Desirability of her conception	Positive	28	46
	Negative	11	6

Table 9. Result of Task 2-1

(a)	(b)	Using Ryuta's conception for discussion	
		Positive	Negative
Desirability of her conception	Positive	11	58
	Negative	9	13

We see immediately that the (positive, negative) categories in table 8, table 9, are larger than the other categories in each set of table. According to the χ^2 test for each results (table 8,9), the χ^2 values were 4.075 in table 8, and 6.064 in table 9. The differences of views in both tables are statistically significant ($p<.05$). The result indicates that most pre-service teachers tended to interpret affirmatively pupils' conception, but they were compelled to disregard them in classroom discussion.

So far, we have seen how rough insights into pre-service teachers' belief were gained through their responses to two cases. However, beyond a quantitative grasp, the features of their comprehension are not fully known. Moreover, their responses might depend on their views of teaching mathematics as well as on the cases in question. It is also necessary to check into what was behind their responses and care for them. Therefore, we conducted a more qualitative examination by clinical interview, and this is reported in the next section.

Outline of Clinical Interview

Interviews were conducted for the following purposes: 1) To follow up on pre-service teachers' responses in the questionnaire, and obtain direct information concerning their belief around early mathematics, 2) To

care for their view of teaching early mathematics, with special focus on the balance between mathematical expertise and pedagogical knowledge. The six subjects were selected from the following reason. Result of task1-1, 2-1 shows a possibility that participant who belongs to the (Positive, Negative) category might have some special persistence. Based on the above two items, the interview was conducted using a semi-structured interviewing method (Patton, 1990) that proceeded flexibly according to the subject's reactions. Interviews are analyzed from two viewpoints: (a) the basis of interpretation and responses, and (b) how their views keep or change through discussion of two cases.

Results of interview and Discussion

Since there is not enough space to give the results of all interviews, and the two subjects who selected are because of having been the same reply tendency as two subjects besides each. Particularly, we outline the two episodes of PT 1 and PT 2, who showed the most interesting tendencies.

About PT1, when asked to explain the reason why did he not make Makiko's conception the object of classroom discussion, PT1 said, "What is necessary is just to limit the definition of the divisor to the range of natural number. But I might not want her to speak it loudly". After checking the formal definition of divisor in number theory on the math text, he changed his approach for teaching of the divisor and multiple. During the interview, his interpretation appeared most directly in the following dialogs. (Int.: Interviewer)

PT1:	Um... Makiko wish to extend the concept of divisor and multiple. ...(pause)...um...it is good attitude for math....but...timing is important, too.
Int :	Indeed. Well, how do you decide the timing to teach about divisibility relation and discuss her idea in class?
PT1:	..Um...maybe...not.... It might get confusing.....in elementally school... honestly.... I was very surprised to hear her suggestion. Since checking the exact definition, we can not state about this.

About PT2, in first half of interview, she consistently emphasized that "Ryuta's idea is good for himself (personally)", and "it is not duty to pick up his idea because that is not formal contents of elementary school". After tutorial learning of divisibility relation and modular system, PT2 had started to think about the didactical implication of picking Ryuta's idea. The following comment expresses the feature of PT2's view on the role of the elementary mathematics teacher. These tendencies are frequently found in second half.

Int :	Hmmm, so please tell me what do you feel about the response to Ryuta?
PT1:	...So...it had little merit to be taken up in classroom, initially. ...now I also regard this Ryuta's idea as good opportunity to get awareness of general principle in classroom, somehow...if possible...we can take care him if we well know background.
Int :	Background ?
PT1:	It means... exact mathematics. To be more thoughtful....I think...

Above dialogues describe how PT1 and PT2 interpreted pupils advance question that was not expected to have been taught in elementary school. At least they acknowledged two pupil's interests and attitudes. During the second half of interview, PT1, and PT2 had tried to become knowledgeable about advanced mathematics in order to teach arithmetic deeply.

4. Concluding remarks

The purpose of this research is to investigate some tasks of professional development of pre-service primary mathematics teachers, and to verify the potential of case method for growth of pre-service primary mathematics teacher. From what has been discussed above, overall, we could get the following two main findings:

(a) Japanese pre-service mathematics teachers would not realize the necessity of advanced mathematics to educate elementary pupils on arithmetic.

(b) Case method could be an effective tool to link between the practical decision making in classroom and mathematical subject matter knowledge.

We should look more carefully into these findings because one of the primary roles of early mathematics teachers is to help pupils construct appreciated conceptions based on their pedagogical knowledge at different levels.

Note

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要　約

本稿は, 小学校教師を志望する日本の大学生 91 名を対象としたケースメソッドの実践について，数学的リテラシー育成を事例として報告するものである．質問紙及び面接調査で確認された同法による指導効果として，⑴小学校算数を児童に指導することと大学において高等数学を学ぶことを関連づける必要性についての実感を促すこと，⑵教室における数学の教科内容知識と教室での実践的な意思決定を結びつけること，が確認された.

（訳：小原　豊）